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FINAL REPORT

Assessment of Geology, Energy, and Minerals (GEM) Resources

CEDAR RIDGE GEM RESOURCE AREA

(NV-010-05)

ELKO COUNTY, NEVADA

Prepared for

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

March 1983

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Cedar Ridge GRA
(NV - 010 - 05)
Elko County, Nevada

Prepared For:

United States Department of the Interior
United States Bureau of Land Management
Scientific Systems Development Branch

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BLM Contract No.: YA - 553 - CT2 - 1042

March, 1983

This report was prepared as part of a Phase I Assessment of GEM Resources within designated Wilderness Study Areas in Oregon, Idaho and Nevada.

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All members of the panel of experts provided valuable input into these assessments of GEM resources for each of the GEM Resource Areas (GRAs). Their professional approach to the problems and their interpretations of available literature and data form the foundation upon which the assessments for this project are based. We are grateful for their efforts and skills in this project. The panelists and their area of expertise are:

- Dr. Antonius Budding - Oil Shale and Tar Sands
- Mr. Raymond Corcoran - Field Verification
- Dr. James Firby - Paleontology
- Mr. Ralph Mason - Coal
- Mr. Richard Miller - Uranium and Thorium
- Mr. Vernon Newton - Oil and Gas
- Mr. Herbert Schlicker - Industrial Minerals and Geologic Hazards
- Dr. Walter Youngquist - Geothermal
- Dr. Paul Weis - Metals and Non - Metals.

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Ms. Pamela Ruhl provided clerical and editorial assistance throughout the project. Ms. Sara Mathews assisted with occurrence information and drafting. Mr. Philip R. Jones and Mr. Michael A. Becker produced all documents relating to the project using TERRADATA's word processing and document production systems.

EXECUTIVE SUMMARY

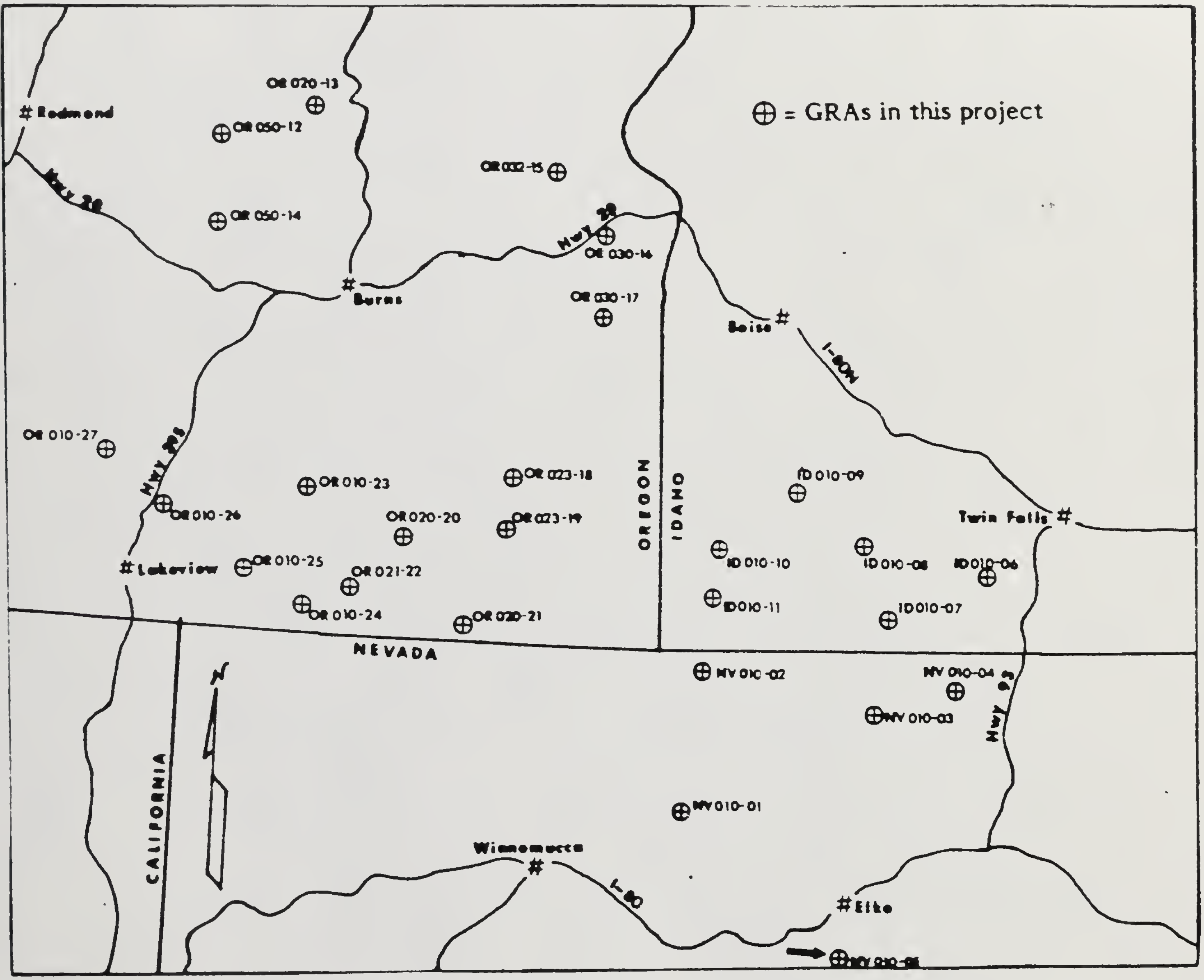
The purpose of this project is to evaluate and classify environments favorable for the occurrence of geology, energy, and minerals (GEM) resources in selected wilderness study areas (WSAs) in southeastern Oregon, southwestern Idaho, and northern Nevada. **(See TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")** GEM resource environments have been rated on a scale that ranges from one to four, with one being least favorable and four being most favorable. Favorability classes two and three represent low and moderate favorability, respectively. Confidence levels range from A to D with A being low confidence and D being high confidence. The confidence levels are directly related to the quantity and quality of the information available for the determination of the favorability classes.

The specific area with which this report deals is the Cedar Ridge GEM resource area (GRA number NV-010-05) which is located in northeastern Nevada (see attached location map). The GRA contains about 108 square miles within Townships 29N and 31N and Range 55E. It contains two WSAs; WSA 010-088 which comprises 10,009 acres, and WSA 010-091, which comprises 7,847 acres. The study area is in the Elko Resource Area of the Elko BLM District. It is about 15 miles south of Elko, Nevada.

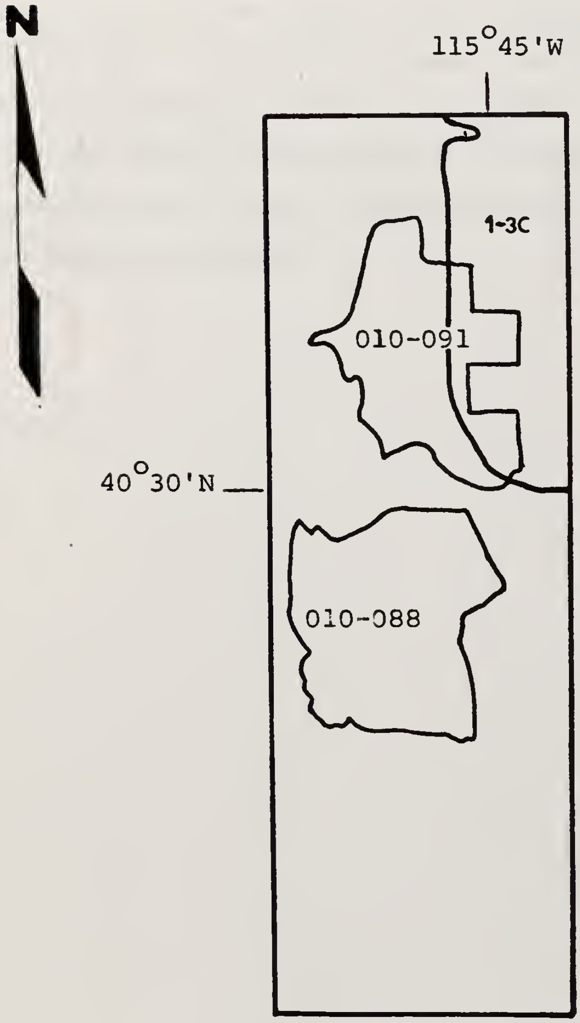
The GRA is within the Great Basin subprovince of the Basin and Range physiographic province. It contains rocks that range from Paleozoic miogeoclinal sediments to Tertiary volcanics and volcanistic strata. The area is east of the major structural Antler orogenic belt, and near the Lynn-Railroad mineral belt. Basin and Range fault blocks are common in this portion of Nevada.

The Cedar Ridge GRA contains several geologic environments that are variously favorable for GEM resources. The area labeled 1-3C on the attached Land Classification Map is favorable for the occurrence of uranium deposits. This area is classified 3C, signifying that the geologic environment, the inferred geologic processes and the reported mineral occurrences indicate moderate favorability for the accumulation of uranium, and that the available data provide direct evidence but are quantitatively minimal to support the possible existence of mineral resources. The classification is based on two important criteria. The favorable area contains an environment similar to that found in other Tertiary basins in which penecontemporaneous uranium deposits occur.

GRA Location Map



Land Classification Map
Cedar Ridge GRA
(NV - 010 - 05)
Elko County Nevada



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(Elko 1°x2° NTMS Quadrangle)

The entire GRA is favorable to varying degrees for metals, coal, oil and gas, oil shale, limestone, bentonite, zeolite, turquoise, perlite, and paleontological resources (see attached table). The area does not exhibit favorable characteristics for other GEM resources.

TERRADATA recommends that further surface geologic investigations be undertaken in the Cedar Ridge GRA in order to increase confidence levels in the classifications. Detailed geologic mapping, geophysical, and geochemical investigations would be useful in upgrading the land classification of this area. Selective drilling of geochemical and/or geophysical anomalous areas would contribute to the refinement of the confidence level and favorability rating in this GRA.

Classification Of Lands Within The
Cedar Ridge GRA
(NV - 010 - 05)
Elko County, Nevada
For G - E - M Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals	Entire GRA	2	C	
Geothermal	Entire GRA	1	D	
Uranium/Thorium	Area 1-3C	3	C	
	Rest of GRA	1	B	
Coal	Entire GRA	2	C	
Oil and Gas	Entire GRA	3	C	
Tar Sands/Oil Shale	Entire GRA	2	B	
Limestone	Entire GRA	4	D	
Bentonite	Entire GRA	3	A	
Diatomite	Entire GRA	1	B	
Clinoptilolite	Entire GRA	2	A	
Barite	Entire GRA	1	A	
Turquoise	Entire GRA	2	A	
Perlite	Entire GRA	2	A	
Phosphate	Entire GRA	2	A	
Paleontology	Entire GRA	3	A	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

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1. INTRODUCTION

This report is one of 27 GRA technical reports that summarize the results of a Phase 1 assessment of the geology, energy, and minerals (GEM) resources in selected portions of southeastern Oregon, southwestern Idaho, and northern Nevada. The study region was subdivided into 27 GEM resource areas (GRAs), principally for ease of data management and interpretation. The assessment of GEM resources for this project consisted of an interpretation of existing literature and information by experts knowledgeable in both the geographic area and specific commodities. A restricted field verification program was also conducted. It is possible that the assessment would be different if detailed field exploration, geochemical sampling, and exploratory drilling programs were undertaken. (See the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources.")

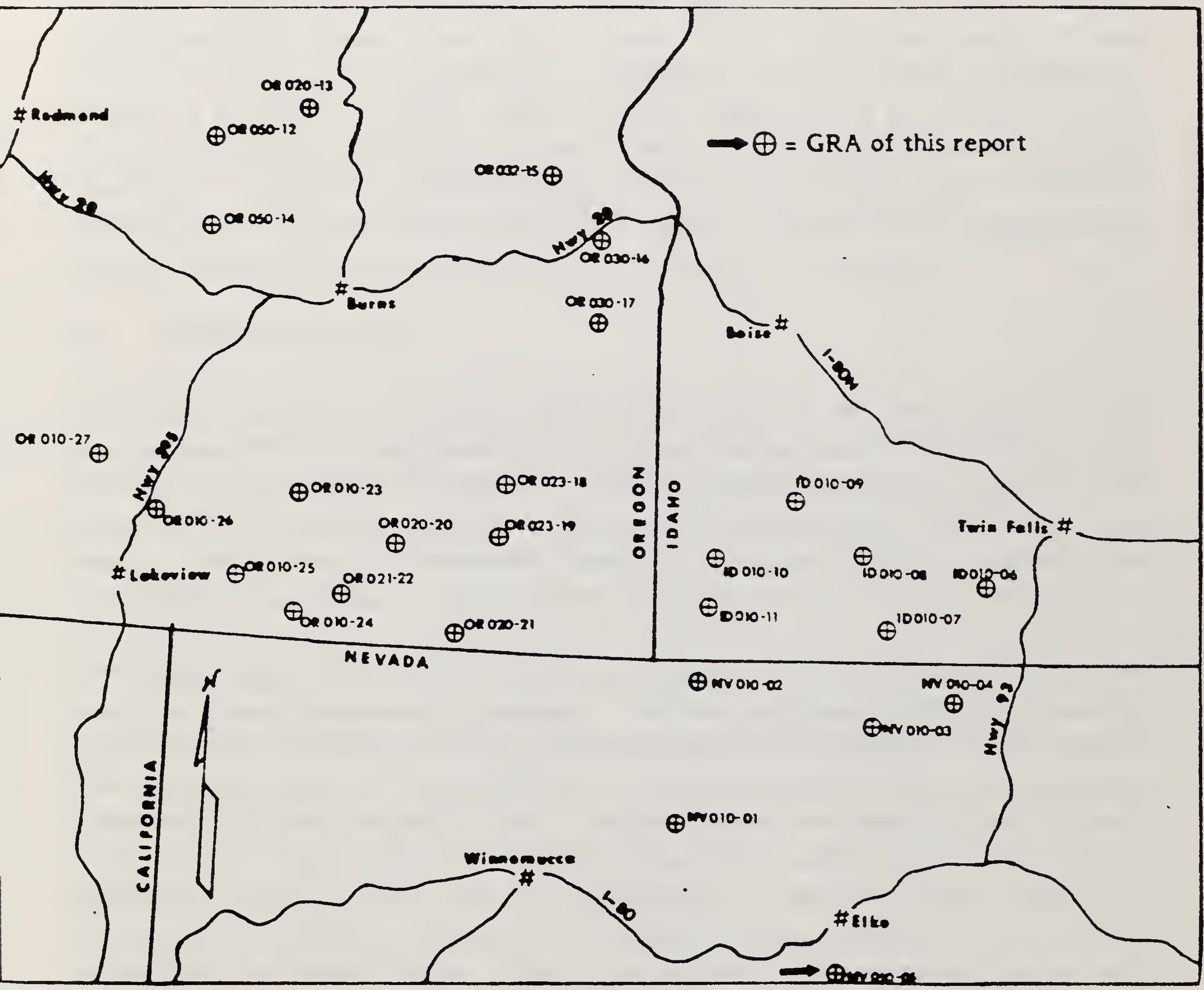
This report summarizes the assessment of the GEM resources potential of the Cedar Ridge GRA (NV-010-05). See Figure 1-1. Commodity categories for which this GRA was evaluated are:

- Metals
- Oil and Gas
- Oil Shale and Tar Sands
- Geothermal
- Uranium and Thorium
- Coal
- Industrial Minerals
- Paleontological Resources
- Geologic Hazards
- Educational and Scientific Localities (ESLs)

Geologic environments within the Cedar Ridge GRA have been rated with respect to their favorability for the occurrence of these different commodities. The favorability rating scale ranges from one to four, with one being least favorable and four being most favorable. Confidence levels in these ratings also have been assigned. These confidence levels range from A to D, with A being low confidence and D high confidence. Assigned confidence levels are related to the quantity and quality of the information available for the determination of the favorability ratings.

FIGURE 1-1

GRA Location Map



2. DESCRIPTION OF THE CEDAR RIDGE GRA

2.1 LOCATION

The Cedar Ridge GRA (NV-010-05) is in northeast Nevada. It lies between latitudes 40°20'N and 40°37'N and longitudes 115°43'W and 115°52'W. The GRA contains approximately 108 square miles within Townships 29N and 31N and Range 55E (see Figures 1-1 and 2-1). The area contains two Wilderness Study Areas; WSA 010-091 (7,847 acres) and WSA 010-088 (10,009 acres). The Cedar Ridge GRA is in the Elko Resource Area of the Elko BLM District. The area is about 15 miles from Elko, Nevada, which is the nearest transportation center offering a minimum of rail, highway, and/or charter-air services. Access to the contained WSAs is via county maintained dirt or packed-gravel roads. Vehicular access to the interior of the WSA is poor to non-existent.

2.2 GENERAL GEOLOGY

The Cedar Ridge GRA is in the Elko 1°x2° NTMS Quadrangle. The data available for this area includes NURE investigations(1, 2, 3)*, general mineral resource information(4), and limited large scale geologic mapping(3). Detailed geologic information is scarce for the entire GRA. Occurrence information for this GRA includes MILS, NURE, claims, and leases. The quantity of commodity specific information is small. The available information is poor to fair for all commodities; most do not occur in or near the area.

The Cedar Ridge GRA is within the northern section of the Great Basin portion of the Basin and Range physiographic province. The Basin and Range Province consists of generally north-trending fault-block mountains separated by parallel intermontane basins. The mountain blocks are commonly ten to twelve miles wide and are separated by alluviated valleys of comparable width. Elevation ranges from below sea level at Death Valley to more than 13,000 feet at White Mountains Boundary Peaks. Local relief generally is less that 5,000 feet. The physiography of the Great Basin reflects the structural and lithologic complexity of the underlying bedrock. The Great Basin portion of the Basin and Range Province extends from southern Nevada northward into southern Oregon. The northern-most extremity is located just north of the town of Burns, Oregon. Rocks in the area range from Paleozoic eugeoclinal-miogeoclinal suites to Tertiary volcanogenic and lacustrine strata (see Figure 2-2).

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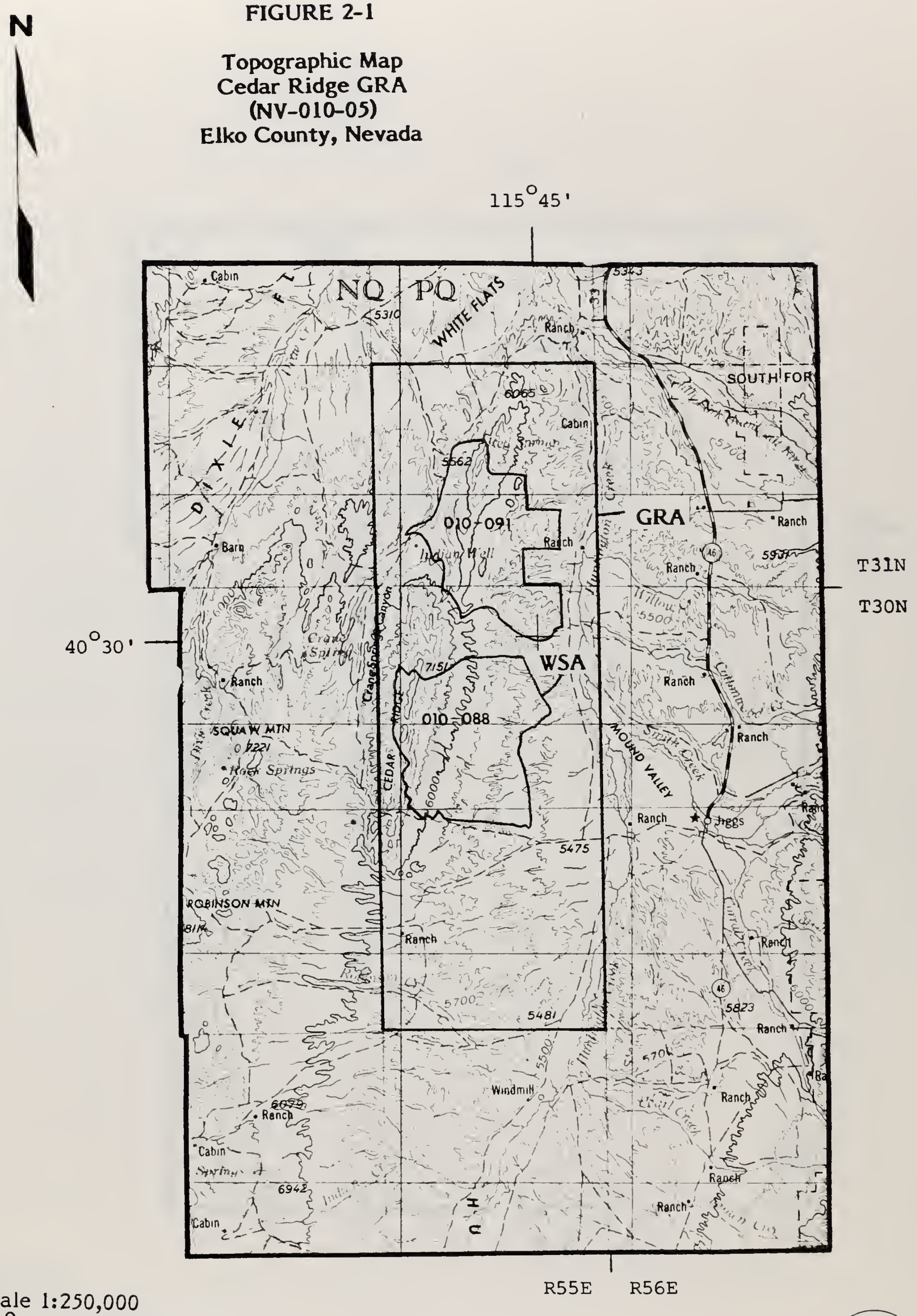
* In this report, citations are superscripted numbers. They refer to bibliographic entries listed in Appendix A: References Cited.

FIGURE 2-1

Topographic Map
Cedar Ridge GRA
(NV-010-05)
Elko County, Nevada



Scale 1:250,000
(Elko 1°x2° NTMS Quadrangle)

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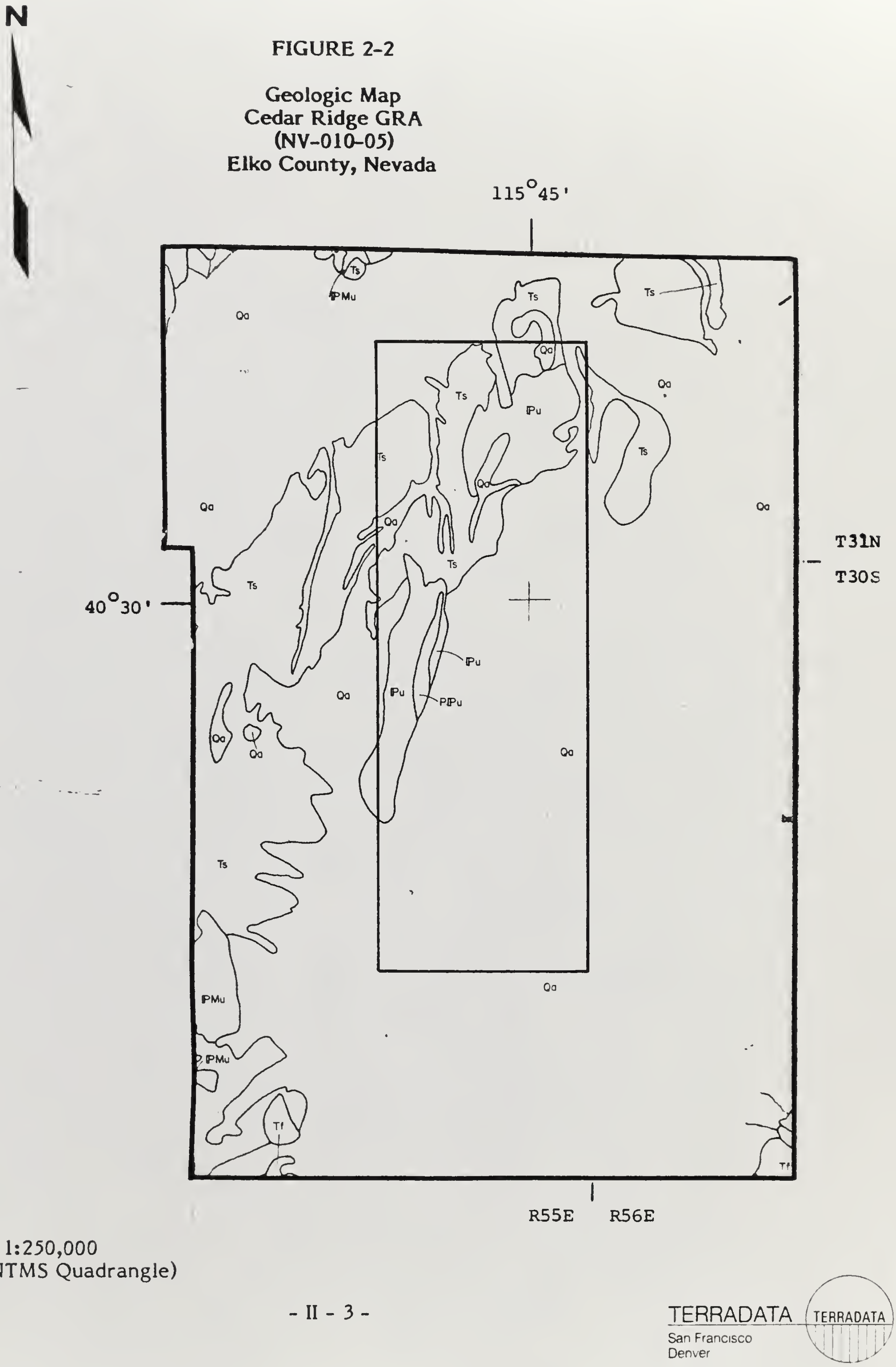
FIGURE 2-2

Geologic Map
Cedar Ridge GRA
(NV-010-05)
Elko County, Nevada



Scale 1:250,000
(Elko 1°x2° NTMS Quadrangle)

FIGURE 2-2
(Continued)

Geologic Map Legend For
Cedar Ridge GRA
(NV-010-05)
Elko County, Nevada

Qa - Alluvium: Silt, sand, and gravel along streams, including terrace deposits.

Ts - Tertiary Sediment Rocks: Dominantly tuff and welded tuff. Includes minor clastics and carbonates.

Tf - Felsic Volcanic Extrusives: Dominantly rhyolites to dacites; flows and domes.

Ti - Igneous Intrusives: Mainly granite, rhyolite and quartz monzonite.

PIPu - Permian-Pennsylvanian Carbonates: Limestone and dolomite. Includes Buckskin Mountain, Beacon Flat, Carlin Canyon, Strathearn, Sunflower, Winecup, and Ferguson Mountain Formations.

IPu - Pennsylvanian Sedimentary Rocks, Undifferentiated: Dominantly limestones, minor clastics, and andesitic tuff. Includes Mitchell Creek, Quilici, Moleen, Tomera, and Hogan Formations.

IPMu - Pennsylvanian-Mississippian Clastic Sedimentary Rocks, Undifferentiated: Dominantly conglomerate, sandstone and shale. Includes Diamond Peak, Chainman, Schoonover, and Webb Formations.

Ꞓc - Carbonate Rocks, Minor Quartzite, and Phyllite: Includes Edgemont Formation and Porter Peak Limestone.

- Geologic contact (dashed where inferred).

2.2.1 Geomorphology

The Cedar Ridge GRA comprises a north-northeast trending ridge of Carboniferous limestone that is bounded on the east and west by gently sloping pediment surfaces. The eastward dipping pediment contains numerous intermittent low-order streams that drain into Huntington Creek (Figure 2-1). Streams in the western and northwestern portion of the GRA drain west and north into Crane Springs Canyon and Dixie Creek.

The highest point in the GRA is on Cedar Ridge (7,150 feet) in the west-central portion of the study area, whereas the lowest point is approximately 5,200 feet high. Local relief exceeds 1,000 feet along the western side of Cedar Ridge.

The dominant physiographic feature in the area in the north-northeast trending limestone ridge (the southern portion of which is named Cedar Ridge). This feature is an eastward-dipping homoclinal ridge of massive, light gray-weathering, chert-bearing limestone (see Section 2.2.2). Midway along the ridge is a broad saddle in which Tertiary sediments are exposed. These sediments, principally limestone pebble colluvial-type deposits, may be remnants of a higher level pediment surface that extended above or across the limestone ridge. The present limestone homoclinal ridge (Cedar Ridge and its northern extension) has many of the topographic characteristics of a bornhardt. It is being exhumed by the current erosion cycle.

The break between this pediment and the associated bajada on the eastern side of the GRA (off the eastern margin of Cedar Ridge and its extension) is not known. No gravity or seismic data are available to interpret the location of the basin-bounding fault. Based on topographic expression, the pediment-bajada boundary is interpreted to lie within the eastern one-quarter of the GRA. This is outside the boundaries of the contained WSAs. The location of the bounding fault on the western side of this horst is not known. It is most likely west of the GRA boundary.

2.2.2 Lithology and Stratigraphy

The oldest rocks exposed in the Cedar Ridge GRA are Pennsylvanian carbonates. These are exposed along Cedar Ridge and its north-northeastward extension. These rocks are massive, light gray-weathering limestones that contain layers, stringers, and nodules of light tan chert. The chert layers are parallel to the stratification of the limestone and emphasize the steeply eastward dipping character of the bedding along the crest of Cedar Ridge. The limestone is very sparsely fossiliferous; only one rugosa coral was found during field verification. The limestone ranges from a dense micrite to a fine-grained sparite. It contains a moderately high percentage of floating quartz grains. Although the quartz grains appear to be well sorted within a given stratum (as observed in hand specimen), the average quartz grain size appears to be different in different strata. The origin of the floating quartz grains is unknown. The apparent well-sorted character of the grains within the different strata suggests that they were wind-blown.

Resting uncomformably on the steeply dipping carbonates is a flat-lying sequence of Tertiary sandstones, conglomerates, and tuffs. The clastic sedimentary rocks comprise an apparent valley-fill sequence of cross-bedded sandstones and polymictic conglomerates. These are the lowest Tertiary sediments exposed along the flank of the carbonate ridge. Fluvial sandstone comprises the basal portion of this sequence. It is a poorly sorted, cross-bedded sandstone that contains quartz, feldspar, and sand-sized volcanic rock fragments. Interbedded with, and overlying the fluvial sandstone, is a conglomeratic unit that contains variously sorted rounded clasts of several different volcanic rock types, mostly silicic. This sandstone-conglomerate sequence is exposed midway up the west side of Cedar Ridge and appears to be the remnants of a valley-fill sequence. Crane Springs Canyon, which marks the western side of Cedar Ridge, is being re-excavated. The sandstone-conglomerate sequence is being removed during this re-excavation process.

Resting on top of the fluvial sandstone-conglomerate sequence is an oligomictic limestone-pebble conglomerate that is a thick sequence of partially indurated colluvial materials derived from the underlying carbonates. The limestone clasts are angular and are poorly sorted. The matrix consists of silt and fine-grained sand. There is little or no evidence of water transport. This colluvial conglomeratic deposit is interpreted as a pediment veneer that would have to have formed during a pediplanation cycle that preceeded development of the well defined pediment now present along the eastern margin of Cedar Ridge. The dramatically different character of the fluvial sequence and this interpreted pediment veneer limestone-pebble conglomerate marks an apparent shift in the geomorphological regime, perhaps related to a climatic change.

Tertiary sedimentary rocks in the northern portion of the Cedar Ridge GRA compose a thick sequence of vitric, crystal and lithic tuffs. These tuffaceous units are fine-grained, highly welded and form a prominant west-facing scarp along the western side of the northward extension of Cedar Ridge. Although their stratigraphic position within the Teritary section is not known, they are interpreted to be older than the fluvial sandstone-conglomerate valley-fill sequence discussed above. This is based on the presence of clasts of similar lithologies in the fluvial conglomerates.

2.2.3 Structural Geology

The tri-state area of northeastern Nevada, southern Oregon, and southwestern Idaho is characterized by several major structural elements. The most obvious reflections of the structure are the ridges and valleys that resulted from Basin and Range faulting, a relatively young structural event. This is the dominant structural element apparent in the Cedar Ridge GRA.

During the Early Paleozoic this tri-state area was the site of marine sedimentation in the north-northeast trending Cordilleran geosyncline. Sedimentation persisted in three sub-parallel belts until the end of the Devonian Period. One sedimentation belt was located in the eastern half of Nevada and received nearshore to littoral deposits of shallow-water carbonates with a minor amount of interbedded shale and sandstone. The second sedimentation belt was in the western half of the state and was the locus of transitional, progressively deeper water deposits. The third belt, located further west, was the site of eugeoclinal deposits.

In Late Devonian time, the Antler Orogeny developed along a north-northeast trending swath through northwest Elko County, Nevada, and on into southwestern Idaho(5). The Cedar Ridge GRA lies east of the axis of the Antler orogenic belt. The orogeny culminated in a period of extensive thrust faulting that includes the Roberts' Mountain thrust. The Cedar Ridge GRA is located east of the major thrust belt of the Antler Orogeny.

The Sonoma Orogeny occurred in the Permian in north-central Nevada(6). This deformational episode included more thrust faulting west of the Cedar Ridge GRA.

The most obvious structural element is marked by the ridges and valleys that resulted from Basin and Range tensional faulting. This is a relatively young structural event. A tremendous increase in volcanic activity occurred in the tri-state area during the Late

Cenozoic. This is recorded in the large volume of Tertiary extrusives that blanket the area, and is reflected in the Cedar Ridge GRA as a thick sequence of tuffs and the fluvial volcanic sandstones and volcanic conglomerates. Basin and Range block faulting has continued in parts of Nevada throughout historical time.

The major structural feature of the Cedar Ridge GRA is the homoclinal Carboniferous carbonate ridge. The geologic map (Figure 2-2) indicates a southward plunging syncline within Cedar Ridge proper. No evidence of this was found during field verification, however. The only other significant structural feature spatially associated with this GRA is the horst-bounding fault along the eastern margin of Cedar Ridge and its northward extension. As discussed in Section 2.2.1, the location of this fault is not known.

2.2.4 Paleontology

Permo-Carboniferous marine limestone facies within the Cedar Ridge GRA are sparsely fossilferous. A few, poorly preserved, coelenterates are present. Tertiary sedimentary units within the area comprise Late Miocene and younger lacustrine, fluvial and volcaniclastic strata (Humboldt Formation). Although fossil mammals, mollusks, fish, and leafs have been found elsewhere in the Humboldt Formation, none have been reported from this GRA.

2.2.5 Historical Geology

The present geologic character of the Great Basin resulted from the progressive development of the western portion of the North American continent throughout geologic time. Beginning in the Late Precambrian and continuing into the Middle Paleozoic, eastern Nevada, western Utah, and southwesternmost Idaho were characterized by a miogeoclinal environment in which shelf margin carbonates, shales, and sandstones were deposited. In contrast, western Nevada and southern Oregon were in a eugeoclinal environment in which dark shales, radiolarian cherts and basaltic materials (Steinman's Trinity) were formed.

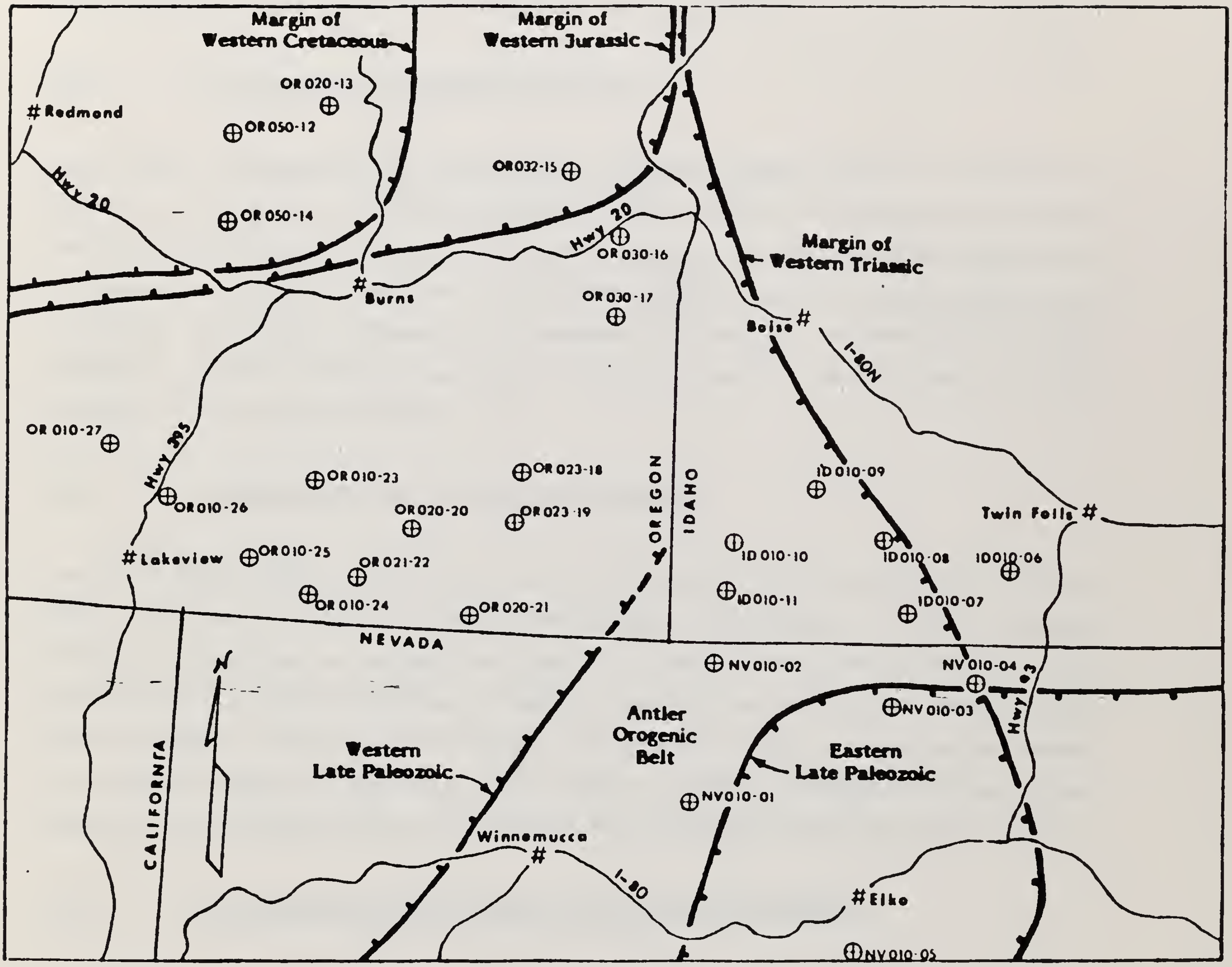
The Middle Paleozoic (Late Devonian-Early Mississippian) Antler Orogeny deformed and thrust the eugeoclinal sediments over the shelf-type sediments to the east, resulting in a north-trending highland in central Nevada. A vast amount of fine-grained detritus was shed eastward during the Mississippian, producing thick upper Paleozoic shales in eastern Nevada and western Utah. Erosion of the Antler Highland resulted in the deposition of coarse sediments during the Early Pennsylvanian. Thousands of feet of sandstone and conglomerate were deposited in northern Nevada around the margins of the Antler Highlands. Late Pennsylvanian and Permian shallow water sediments overlapped and overstepped the roots of the eroded highlands. The carbonates of Cedar Ridge formed during this episode. Sediments deposited over the Antler Highlands in the Permian were predominantly of the deep water variety. The next significant tectonic episode (the Sonoma Orogeny) thrust the ocean floor siliceous and volcanic materials eastward over the shallow water, clastic sedimentary rocks that covered the ancient Antler Highlands.

Development of western North America in the Mesozoic was dominated by oceanic plate subduction along the continental margin that resulted in a complex history of concomittant sedimentation, deformation, and igneous activity. During this time, the well-defined overthrust belt that extends from Canada to Mexico was formed. This deformation occurred during the Sevier (Late Jurassic to Latest Cretaceous) and Laramide orogenies (Latest Cretaceous to Early Tertiary Eocene)(7).

Widespread silicic volcanic rocks formed in the Great Basin in Early and Middle Cenozoic time (primarily 20-34 million years ago). During Late Cenozoic time volcanic activity of the Great Basin changed to a bimodal basalt-rhyolite assemblage that reflects the taphrogenic character of the region. It was also during this time that the tectonic character of the region changed from one of compression to one of extension and led to the development of the Basin and Range structure.

FIGURE 2-3

Paleogeographic Map(6)
Oregon-Idaho-Nevada
Tri-State Area



2.3 ENVIRONMENTS FAVORABLE FOR GEM RESOURCES

The Cedar Ridge GRA is potentially favorable for a wide variety of GEM resources. Although the degree of favorability varies among the different commodities, and the confidence level also is variable, potentially favorable environments may exist for all GEM resources except geothermal, diatomite, barite, and ESLs.

2.3.1 Environments for Metals Resources

No metallic mineralization is known within the Cedar Ridge GRA(8). However, the Railroad district is 12 to 15 miles east of the GRA, and other mineralized areas occur a few miles to the south. Paleozoic carbonates similar to those in this GRA are known to be mineralized in other locations. Such mineralized areas are always spatially, and presumably genetically, related to Cretaceous or Tertiary intermediate to silicic intrusives. No such intrusives are known within or near the Cedar Ridge GRA. The likelihood of mineralization is low.

2.3.2 Environments for Oil and Gas Resources

The Cedar Ridge GRA is moderately favorable (Class 3) for the occurrence of oil and gas(6). The area is within the eastern Late Paleozoic marine basin. As such it may be underlain by potential source and host rocks. It also is within the boundaries of the Eocene-Oligocene Elko Formation lacustrine deposits and within the Miocene Lake Bruneau deposits. Oil and gas shows have been reported from a well drilled just outside the southeast corner of the GRA. This direct evidence, although minimal, allows assignment of a confidence level of C to the Cedar Ridge GRA for oil and gas resources.

2.3.3 Environments for Oil Shale and Tar Sands Resources

The northern section of the Cedar Ridge GRA contains Tertiary sedimentary rocks. Rocks of generally similar age in the Pinyon Range six miles to the west have exposures of kerogen-bearing shales(9). On the basis of this scant information, the northern portion of the GRA was tentatively classified 2B for the occurrence of an environment favorable for oil shale. However, field verification indicated that the exposed Tertiary sediments in the northern portion of the GRA are principally tuffs. This does not preclude the existence of unexposed, interbedded kerogen-bearing shales. However, the likelihood of such an occurrence is small.

2.3.4 Environments for Geothermal Resources

The Cedar Ridge GRA contains no environments favorable for geothermal resources because requisite geologic criteria are not satisfied in the area(10). The lack of any Tertiary volcanics (except the tuffs, which probably originated outside the GRA) is a decidedly negative criterion. There are no known geothermal resources nor leasing activity in the area. There is little likelihood that this GRA could contain any geothermal resources.

2.3.5 Environments for Uranium and Thorium Resources

The northeastern part of the Cedar Ridge GRA, including the eastern portion of WSA 010-091, is underlain by tuffaceous sedimentary rocks of the Miocene Humboldt Formation. These rocks are moderately favorable (Class 3) for the occurrence of uranium deposits(3, 11). The potential host rocks consist of tuffaceous, feldspathic sandstone with interbedded conglomerate lenses. This area is favorable for the occurrence of peneconcordant sandstone-type uranium deposits because it meets the following criteria:

- Favorable host.
- An apparent source (rhyolitic tuffaceous material).
- Similarity to uranium-bearing environments in Wyoming and other Tertiary basins in the Rocky Mountain region.
- Presence of the Huntington Creek Valley uranium prospect in the Humboldt Formation in the northeast corner of the GRA and the White Hill uranium prospect approximately six miles east of the northeast corner of the GRA(3).

Because of the known occurrence of uranium in this environment, the assigned favorability classification for the Cedar Ridge GRA is C.

2.3.6 Environments for Coal Resources

The Cedar Ridge GRA contains low favorability for the occurrence of coal and lignite deposits(12). The chances for coal or carbonaceous materials to have formed in the study area are remote. The geology of the Cedar Ridge GRA region does not support environments favorable for the formation of coal deposits. Much of the area is underlain by marine carbonates or is mantled with accumulations of highly tuffaceous sediments and related volcanic products. There is no evidence to support the inference that a coal-forming environment existed within this GRA.

2.3.7 Environments for Industrial Minerals Resources

Because of the variety of lithologies and geologic environments present in the Cedar Ridge GRA, there are varying degrees of favorability for various industrial mineral resources(13). These are:

- **Limestone.** Classification 4D. Upper Paleozoic limestones underlie portions of Cedar Ridge and its northern extension.
- **Bentonite.** Classification 3A. Bentonite is developed from the weathering of silicic volcanic and volcanoclastic materials. These units are present in this area. There is insufficint information, however, to indicate whether sufficient weathering and alterations have occurred to generate bentonite deposits.
- **Clinoptilolite.** Classificiation 2A. Some of the Tertiary tuffaceous material may have been altered to form zeolites. There is insufficient evidence, however, to support or refute this contention.
- **Turquoise.** Classification 2A. Turquoise has been reported in rocks of similar composition 18 miles northwest of the Cedar Ridge GRA. None has been reported from this area, however.
- **Perlite.** Classification 2A. Perlite occurs about 12 miles west of the Cedar Ridge GRA in volcanic rocks whose composition is similar to the tuffaceous units in this area. This area has a low favorability for similar occurrences even though there are no known deposits within the area.

2.3.8 Environments for Paleontological Resources

Paleontological assembleges that could occur in the Cedar Ridge GRA range from those representing carboniferous marine facies to those representing Tertiary non-marine facies(14).

Permo-Pennsylvanian carbonate units within the Cedar Ridge GRA are very sparsely fossilferous. The majority of the Tertiary sedimentary units (geologic map unit Ts) are Late Miocene or younger and consist of lacustrine, fluvial, and volcaniclastic strata of the Humboldt Formation. Fossils found elsewhere in the Humboldt Formation include mammals, non-marine mollusks, fish, and leaf flora. The overall evaluation of the Cedar

Ridge GRA for paleontological resources is 3A.

2.3.9 Environments for Geologic Hazards

Potential geologic hazards in the Cedar Ridge GRA consist of interpreted faults and potential landslides(13). These features were noted from aerial photographs, geologic maps, and topographic maps. There is no historical record of violent seismic or volcanic activity in the area. The potential for mass movement exists along all the over-steepened slopes within the GRA.

2.3.10 Educational and Scientific Localities

There are no known ESLs in the Cedar Ridge GRA.

3. ENERGY AND MINERAL RESOURCES IN THE CEDAR RIDGE GRA

Parts of WSA 010-088 and WSA 010-091 within the Cedar Ridge GRA have low, moderate, and high favorability for the occurrence of several GEM resources.

3.1 KNOWN DEPOSITS

The Cedar Ridge GRA contains no known deposits.

3.2 OCCURRENCES

The Cedar Ridge GRA contains no CRIB localities, two MILS localities (Figure 3-1), and one NURE locality(3). MILS listings for this area are of prospects; no production has been reported.

3.3 CLAIMS

The Cedar Ridge GRA contains 66 claims (Figure 3-2), all of which are in two sections along the eastern boundaries of the GRA. None of the claims are in either WSA 010-088 or WSA 010-091. Claims information is current as of 15 August, 1982,

3.4 LEASES

The northern one-third (approximately) of the Cedar Ridge GRA is currently leased or is under lease application for oil and gas(6). This leasing activity includes nearly all of WSA 010-091, but none of WSA 010-088. Lease information is current as of 15 August, 1982.

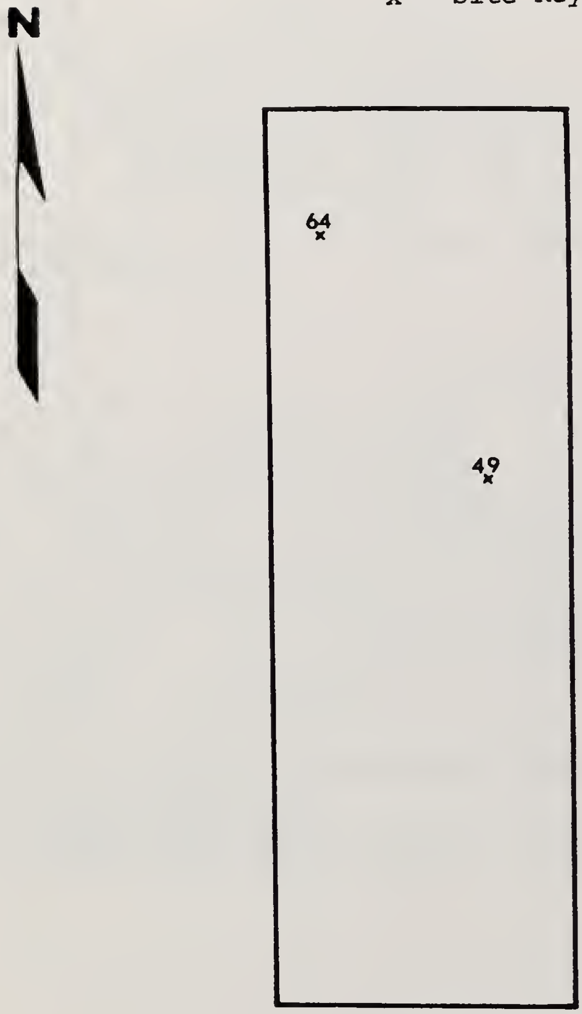
3.5 DEPOSIT TYPES

Nevada is divided into two distinct metallogenic provinces based on the distribution of known metallic occurrences and related lithologic and stratigraphic considerations. The western half of Nevada is characterized by major gold, silver, tungsten, antimony, mercury, and iron deposits that occur in Paleozoic and Mesozoic silicious intrusive and volcanic rocks and Tertiary volcanic rocks. Eastern Nevada is characterized by major lead and zinc deposits with associated gold and silver in Precambrian rocks and Paleozoic carbonates. The study area lies just west of the transition zone between the two metallogenic provinces(4).

FIGURE 3-1

MILS Localities Map
Cedar Ridge GRA
(NV-010-05)
Elko County, Nevada

49 x = Site Keyed to Explanation



Scale 1:250,000
(Elko 1°x2° NTMS Quadrangle)

This map is an overlay for Figures 2-1 and 2-2.

FIGURE 3-1
(Explanation)

```
    99
49 NAME- ESTHER MINING CLAIM                            REFERENCE NUMBER- 0320070324
   STATE- NEVADA                        COUNTY- ELKO                              ELEV:PREC- 1737M:500M
   LATITUDE-   N 40 30 01          PRECISION- >10KM
   LONGITUDE- W 115 45 01  REFERENCE POINT- APPROX
   UTM:  ZONE 11N  NORTHING 4483923  EASTING 605898
   PUBLIC LAND SURVEY  TOWNSHIP- 030 N   RANGE- 055 E
       DESCRIPTION      SECTION- 11  SECTION SUBDIVISION-
   RIVER BASIN- 68C   SOUTH FORK HUMBOLT RIVER   DOMAIN- UNKNOWN
   STATUS- UNKNOWN          OPERATION TYPE- MINERAL LOC
   MESA ID NO.             YEAR FIELD CHECKED-        MAP REPOSITORY-  FOC
   MAP NAME- DIXIE FLATS          TYPE- 15 MIN
   1:250,000 MAP NAME- ELKO                      MINERAL PROPERTY FILE- 06.014
   PRIMARY NAME- ESTHER MINING CLAIM
   COMMOD MOD-

  154
64 NAME- ATLANTIC                                       REFERENCE NUMBER 0320070003
   STATE- NEVADA                        COUNTY- ELKO                              ELEV:PREC- 2621M:100M
   LATITUDE-   N 40 34 15          PRECISION-  500M
   LONGITUDE- W 115 48 49  REFERENCE POINT- APPROX
   UTM:  ZONE 11N  NORTHING 4491582  EASTING 600425
   PUBLIC LAND SURVEY  TOWNSHIP- 031 N   RANGE- 060 E
       DESCRIPTION      SECTION- 13  SECTION SUBDIVISION- N2NW
   RIVER BASIN- 36I   DUCK CREEK                    DOMAIN- BLM ADMIN
   STATUS- DEVEL DEPOSIT  OPERATION TYPE- PROSPECT
   MESA ID NO.             YEAR FIELD CHECKED-        MAP REPOSITORY-  FOC
   MAP NAME- SPRUCE MOUNTAIN     TYPE- 15 MIN
   1:250,000 MAP NAME- ELKO                      MINERAL PROPERTY FILE-
   PRIMARY NAME- ATLANTIC
   COMMOD MOD-  TUNGSTEN         WO3 CONTENT
   USGS OPEN FILE MAP,1970,OF ELKO CO.
   USGS BULL 648,1916
   NEV BUR OF MINES BULL 14,1931,P.7-24,(AREA DISCUSSION)
   HARLOW:G.R.,UNIV OF WASH,1956,M.S.
   NEV BUR OF MINES TUNGSTEN GRANT,USBM
   SMITH, ROSCOE M, MINERAL RESOURCES OF ELKO COUNTY, NEVADA
   USGS OPEN FILE REPORT, 1976-56, 1976, P. 20.
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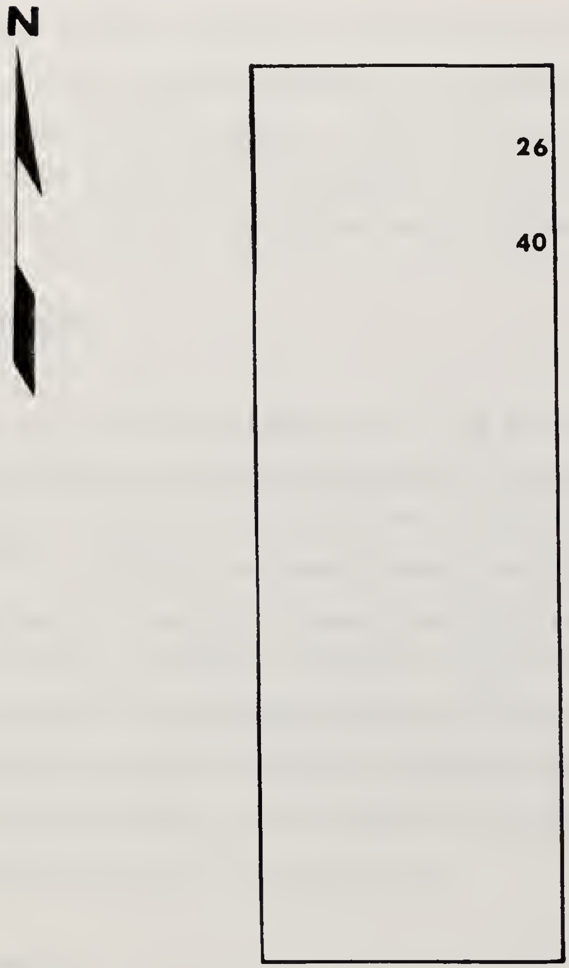
FIGURE 3-2

Claims Density Map
Cedar Ridge GRA
(NV-010-05)
Elko County, Nevada



n = number of claims per section

This map is an overlay for Figures 2-1 and 2-2.

The only specific deposit type found in or near the Cedar Ridge GRA that can be used as a model in predicting specific favorable environments is the Huntington Creek Valley uranium prospect(3, 11). This is discussed in Section 2.3.5.

3.6 MINERAL ECONOMICS

There are no known mineral deposits or mining activity within or adjacent ot the Cedar Ridge GRA. The area is highly favorable for limestone and moderately favorable for uranium, oil and gas, and bentonite. Exploration and development of oil and gas resources in this GRA may occur in the future. However, despite leasing activity in the northern portion of the GRA, no drilling has occurred near the GRA since 1971.

3.6.1 Limestone

Lime, limestone, and calcined gypsum, are used primarily in steel furnaces, water treatment, Portland cement, paper and pulp, and in the desulfurization of sour gas. Ohio, Pennsylvania, Missouri, Illinois, Texas, Alabama, and Kentucky produce 47 percent of the total output(15, 16). Although the United States production of lime has increased nearly 14 percent in the last 12 months, it is predicted to increase at an annual rate of two and one-half percent through 1990(15). The lime market has expanded largely because of environmental regulation of industrial effluents and emissions. Estimated United States consumption of lime will exceed domestic production by 300,000 tons in 1982. Foreign sources of industrial lime products are Canada, 94 percent; and Mexico, six percent. The current average price for lime is $47.00 per ton.

3.6.2 Uranium

Two varieties of uranium are currently used in the United States. One, enriched uranium, uranium in which the U^{235} isotope content has been mechanically and chemically upgraded, is an energy resource used in nuclear applications. The second variety, uranium produced as a by-product of the enrichment process, is used in the manufacture of armor piercing shells, in ballast in ships and aircraft, as containers for spent nuclear reactor residuals, and in research(17). Uranium production in the United States from 1974 to 1979 rose nearly 37 percent; and from 1979 to 1980 it rose by only five percent(18). This decrease in production reflects the current increases in production costs and the cancellation of several proposed nuclear power plants. This is forcing an increased reliance reliance on foreign uranium sources in order to fill domestic commitments. Imports are projected to exceed exports in 1985 by nearly 2,000 tons of U_3O_8. Studies of production capability indicate that future demands can be met if production incentives are enhanced and maintained.

3.6.3 Oil and Gas

Oil and gas are vitally important to the industrial growth and development of the United States, and to the overall standard of living. Gross supply and demand trends indicate that during the present decade foreign oil will make up at least 45 percent of our national oil requirements. Present domestic production is 8.6 million barrels per day. The United States currentyly has a 37 million barrel per day equivalent energy demand. It is predicted that by 1990 the United States will produce 8.8 million barrels of oil per day. The equivalent energy demand will increase to 40 million barrels per day(19). During this same period, crude oil demand will decrease by nearly 5 percent, from 16 million barrels per day to 14 million barrels per day equivalent. This decrease is thought to be related to an increase in the use and development of other domestic energy sources, consumer conservation practices, and a predicted slight increase in crude oil production by 1990(19). Because many (most?) shallow sources of crude have been or are being depleted, deeper, more difficult targets of oil and gas are being sought. This may result in a rise in the price of crude by 1990 to $61.00 per barrel(19). This may reverse the trend of surplus supplies that began last year. It may cause shortages(20).

3.6.4 Bentonite

The primary uses of bentonite are in drilling mud, foundry sand, Portland cement, filtrates, pond and reservoir sealing, and for pelletizing (iron ore). Wyoming, Montana, and California are the chief producers of high-swelling, or sodium, bentonites. Missouri, Pennsylvania, and Ohio are the chief producers of low-swelling, or calcium, bentonites(22).

The United States is a net exporter of all clays. The demand for all clays is expected to increase at an annual rate of between two percent and four percent through 1990. The United States' position as a major supplier of clays is enhanced by the possession of more than adequate resources and the technology necessary to process large amounts of high-quality clays(23).

3.7 STRATEGIC AND CRITICAL MINERALS AND METALS

The Cedar Ridge GRA is not favorable for any strategic or critical metals or minerals as listed in the BLM-supplied compilation given in Table 3-4 of the TERRADATA report entitled "Procedures for the Assessment of Geology, Energy, and Minerals (GEM) Resources."

4. CLASSIFICATION OF LAND FOR GEM RESOURCES POTENTIAL

The precise location of specific favorable environments within a given GRA depends upon three principal factors:

- The precision and specificity of avaliable data;
- The nature (size and spatial distribution) of anticipated deposits as predicted from known models; and
- The geometry of the favorable geologic environments.

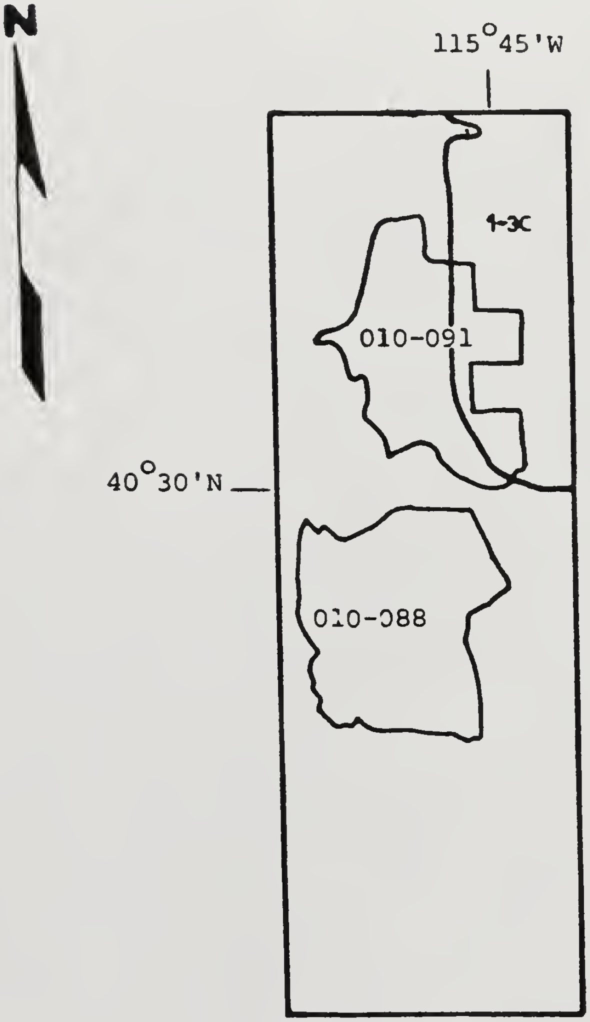
Information in the Cedar Ridge GRA is limited and very general. Therefore, with the single exception of a favorable environment for uranium, the entire area rather than specific subareas has been classified for individual GEM resources (see Figure 4-1 and Table 4-1).

The northeastern corner of the GRA, labelled Area 1-3C on Figure 4-1, is moderately favorable for the occurrence of uranium deposits, Class 3C. The remainder of the GRA is not favorable for uranium concentrations. The entire GRA is favorable (Class 3) for oil and gas resources because it is partially leased or under lease application (as discussed in Section3), it contains potential host rocks for hydrocarbon accumulation, and oil and gas shows have been reported from nearby. The confidence level (C) stems from the fact that hydrocarbon shows near the area provide direct evidence for petroleum favorability. Delineation of specific petroleum fields within the GRA is not possible without extensive exploration work. There is a possibility that oil and gas may occur in Paleozoic, Triassic, and/or Miocene units. The GRA may be underlain by one or a combination of these units.

The USGS includes this GRA in a broad area of land considered to be prospectively valuable for oil and gas(23), and unfavorable for all other leasable commodities(23, 25, 26, 27, 28). TERRADATA's classification is in agreement with the USGS evaluation.

The entire area is favorable (Class 2) for the occurrence of metallic resources, coal, oil shale and tar sands, turquoise, perlite, bentonite and clinoptilolite. Localized deposits of these materials may occur anywhere within the Tertiary volcanogenic hosts. The variable confidence levels given to the favorability designation for these commodities reflects the differing reliability and quantity of available information, and the fact that no deposits of these commodities are known in the area.

Land Classification Map
Cedar Ridge GRA
(NV - 010 - 05)
Elko County Nevada



Scale 1:250,000
(Elko 1°x2° NTMS Quadrangle)

This map is an overlay for Figures 2-1 and 2-2.

TABLE 4-1

Classification Of Lands Within The
Cedar Ridge GRA
(NV - 010 - 05)
Elko County, Nevada
For GEM Resource Potential

COMMODITY	AREA	CLASSIFICATION LEVEL	CONFIDENCE LEVEL	REMARKS
Metals/Non-Metals	Entire GRA	2	C	
Geothermal	Entire GRA	1	D	
Uranium/Thorium	Area 1-3C	3	C	
	Rest of GRA	1	B	
Coal	Entire GRA	2	C	
Oil and Gas	Entire GRA	3	C	
Tar Sands/Oil Shale	Entire GRA	2	B	
Limestone	Entire GRA	4	D	
Bentonite	Entire GRA	3	A	
Diatomite	Entire GRA	1	B	
Clinoptilolite	Entire GRA	2	A	
Barite	Entire GRA	1	A	
Turquoise	Entire GRA	2	A	
Perlite	Entire GRA	2	A	
Phosphate	Entire GRA	2	A	
Paleontology	Entire GRA	3	A	
Hazards	See Hazards Map (GRA File)			
ESLs	None	1	C	

LEGEND:
Class 1 - Least Favorable
Class 2 - Low Favorability
Class 3 - Moderate Favorability
Class 4 - High Favorability

Confidence Level A - Insufficient data or no direct evidence
Confidence Level B - Indirect evidence available
Confidence Level C - Direct evidence but quantitatively minimal
Confidence Level D - Abundant direct and indirect evidence

The GRA is not favorable (Class 1) for all other GEM resources. Confidence levels for all remaining commodities are variable; this denotes that there is insufficient evidence or only indirect evidence for some of these evaluations and adequate information available for others.

5. RECOMMENDATIONS FOR FUTURE WORK

Further work in the Cedar Ridge GRA should be designed to increase the confidence levels of the classifications. Detailed surface investigations should be undertaken for recognition criteria for industrial mineral (e.g., weathering phenomena that might produce bentonite, clinoptilolite; ash flow tuffs with possible basal vitrophyries for perlite, etc.); for metallic deposits, such as soil geochemistry, stream sediment analyses, etc. With the exception of either geophysical investigations or drilling, future work should be confined to detailed mapping, geochemical sampling, and general field exploration.

- APPENDIX A -

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